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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

INVENTOR:	M. Barrera, et al.	)	EXAMINER:	Christopher S. Kim
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SERIAL NO.:	09/675,860	)	ART UNIT:	3752
		)		
FILING DATE:	September 29, 2000	)	DATE:	May 8, 2006

FOR: APPARATUS AND METHOD OF EFFECTIVE FLUID INJECTION AND VAPORIZATION FOR CHEMICAL VAPOR DEPOSITION APPLICATION

AMENDMENT AFTER FINAL

Mail Stop AF
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Dear Sir:

Responsive to the Office Action mailed March 8, 2007, applicants respond as follows:

In the Claims

The claims of the present application are as follows:

1. (currently amended) The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chamber, comprising:

said chemical vapor deposition chamber for processing a semiconductor substrate;

said apparatus ~~for delivering~~delivers said plurality of chemical vapor deposition fluids to said substrate, said apparatus attached to, and in fluid communication with, said chamber, and having a TEOS resilient cavity that prevents TEOS from reaching its auto-ignition point, said cavity comprising an inlet nozzle, a throat region and an exit nozzle,

said inlet nozzle ~~having a first diameter adapted to receive~~receiving a carrier fluid through a first diameter, and having a first pressure and a first temperature;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter and ~~adapted to receive~~receiving said carrier fluid from said inlet nozzle, said throat region having a second pressure lower than said first pressure and a second temperature, and having a first and a second aperture adjacent to said first and second ends ~~for~~ injecting, respectively, a first and a second chemical vapor deposition dopant into said throat region to allow for atomization of said first and second chemical vapor deposition dopants by said carrier fluid and mixing of said atomized first and second chemical vapor deposition dopants with said carrier fluid; and

said exit nozzle, connected to said throat region at said second end, having an exit pressure lower than said second pressure and a third temperature, said exit nozzle having a third diameter greater than said second diameter to allow for a substantial decrease in pressure from said first pressure to said exit pressure, and ~~configured to introduce~~ introducing said mixed atomized first and second chemical vapor deposition dopants and said carrier fluid in the chemical vapor deposition chamber.

2. (currently amended) The combination of claim 1 wherein said inlet nozzle having said first diameter ~~is adapted to receive and funnel~~receives and funnels said carrier fluid to said throat region having said second diameter, said inlet nozzle narrowing at an angle in the range of forty to sixty degrees.

3. (currently amended) The combination of claim 1 wherein said throat region is ~~configured to operate~~operates at a critical Mach number of 1.0.

4. (previously presented) The combination of claim 1 wherein said second pressure and said second temperature are selected to present a condition for atomization of said first and second chemical vapor deposition dopants.

5. (previously presented) The combination of claim 1 wherein said first and second chemical vapor deposition dopants comprise TEOS.

6. (Canceled.)

7. (currently amended) The combination of claim 1 wherein said throat region ~~is configured to maintain~~maintains said first pressure to be greater than said third pressure to enhance atomization of said first and second chemical vapor deposition dopants.

8. (previously presented) The combination of claim 1 wherein said throat region is adapted such that said second pressure is lower than said first pressure allowing for said first and second chemical vapor deposition dopants to be injected into said throat region.

9. (currently amended) The combination of claim 1 wherein said inlet nozzle ~~is adapted to receive~~receives said carrier fluid at a constant flow rate ensuring said second pressure being maintained constant through said throat region.

10. (previously presented) The combination of claim 1 wherein said first and second chemical vapor deposition dopants are introduced simultaneously into said throat region without pre-mixing.

11. (Canceled.)

12. (previously presented) The combination of claim 1 wherein said exit nozzle expands to said third diameter from said throat region second diameter at an angle in the range of twenty to forty degrees.

13. (currently amended) The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chemical vapor deposition chamber, comprising:

said chemical vapor deposition chamber for processing a semiconductor substrate; and

said apparatus ~~for~~ delivering said plurality of chemical vapor deposition fluids to said substrate, said apparatus attached to, and in fluid communication with, said chamber, and having a TEOS resilient cavity that prevents TEOS from reaching its auto-ignition point, said cavity comprising an inlet nozzle, a throat region and an exit nozzle,

said inlet nozzle having a first diameter ~~adapted to receive~~receiving a carrier fluid, and having a first pressure and a first temperature, said carrier fluid comprising a process compatible gas selected from the group consisting of O_2, N_2, and He;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter, and ~~adapted to receive~~receiving said carrier fluid from said inlet nozzle, said throat region having a second pressure and a second temperature and having a first and a second aperture adjacent to said first and second ends ~~for~~ injecting, respectively, a first and a second chemical vapor deposition fluid into said throat region to allow for atomization of said first and second chemical vapor deposition fluid by said carrier fluid and mixing of said atomized first and second chemical vapor deposition fluid with said carrier fluid, said first and second chemical vapor deposition fluids comprise fluids selected from the group consisting of precursors and dopants; and,

said exit nozzle, connected to said throat region at said second end, having said second diameter, said exit nozzle ~~configured to maintain~~maintains said second pressure and said second temperature, such that said exit nozzle is an extension of said throat region consisting of the same dimensions as said throat region, said exit region ~~configured to introduce~~introduces said atomized first and second chemical vapor deposition fluid and said carrier fluid in said chemical vapor deposition chamber.

14. (currently amended) The combination of claim 13 wherein said inlet nozzle having said first diameter ~~is adapted to receive and funnel~~receives and funnels said carrier fluid to said throat region having said second diameter, said inlet nozzle narrowing at an angle in the range of forty to sixty degrees.

15. (currently amended) The combination of claim 13 wherein said throat region is ~~configured to operate~~operates at a critical Mach number of 1.0.

16. (previously presented) The combination of claim 13 wherein said second pressure and said second temperature are selected to present a condition for atomization of said first and second chemical vapor deposition fluid.

17. (previously presented) The combination of claim 13 wherein said first and second chemical vapor deposition fluids comprise TEOS.

18. (Canceled.)

19. (previously presented) The combination of claim 13 wherein said throat region, having said second diameter, is adapted such that said second pressure is lower than said first pressure allowing for said first and second chemical vapor deposition fluid to be injected into said throat region.

20. (currently amended) The combination of claim 13 wherein said inlet nozzle ~~is adapted to receive~~receives said carrier fluid at a constant flow rate ensuring said second pressure being maintained constant through said throat region.

21. (previously presented) The combination of claim 13 wherein said first and second chemical vapor deposition fluids are introduced simultaneously into said throat region without pre-mixing.

22.-25. (Canceled.)

26. (currently amended) The combination of claim 1 wherein said throat region further comprises a third aperture ~~for~~ injecting a third chemical vapor deposition dopant into said throat region to allow for atomization of said third chemical vapor deposition dopant by said carrier fluid, and ~~allow for~~ mixing of said atomized first, second and third chemical vapor deposition dopants with said carrier fluid.

27. (currently amended) The combination of claim 13 wherein said throat region further comprises a third aperture ~~for~~ injecting a third chemical vapor deposition fluid into said throat region to allow for atomization of said third chemical vapor deposition fluid by said carrier fluid, and ~~allow for~~ mixing of said atomized first, second and third chemical vapor deposition fluids with said carrier fluid.

28. (currently amended) The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chamber, comprising:

said chemical vapor deposition chamber for processing a semiconductor substrate; and

said apparatus ~~for~~ delivering said plurality of chemical vapor deposition fluids to said substrate, said apparatus attached to, and in fluid communication with, said chamber, having a cavity comprising a TEOS resilient cross-flow injector, said cross-flow injector comprising an inlet nozzle, a throat region and an exit nozzle;

said inlet nozzle having a first diameter ~~adapted to receive~~receiving a carrier fluid, and having a first pressure and a first temperature, said carrier fluid comprising a process compatible gas selected from the group consisting of O_2, N_2, and He;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter, and ~~adapted to receive~~receiving said carrier fluid from said inlet nozzle, said throat region having a second pressure and a second temperature and having a first and a second aperture adjacent to said first and second ends ~~for~~ injecting, respectively, a first and a second chemical vapor deposition dopants into said throat region to

allow for atomization of said first and second chemical vapor deposition dopants by said carrier fluid and mixing of said atomized first and second chemical vapor deposition dopants with said carrier fluid; and,

said exit nozzle, having an exit pressure, connected to said throat region at said second end for receiving said atomized first and second chemical vapor deposition dopants and said carrier fluid; and

wherein said chemical vapor deposition chamber ~~is adapted to receive~~receives said mixture of atomized first and second chemical vapor deposition dopants with said carrier fluid from said exit nozzle of said cavity.

29. (currently amended) The combination of claim 28 wherein said exit nozzle has an exit pressure lower than said second pressure and a third temperature, said exit nozzle having a third diameter greater than said second diameter to allow for a substantial decrease in pressure from said first pressure to said exit pressure, and ~~configured to introduce~~introduces said atomized first and second chemical vapor deposition dopants and said carrier fluid in the chemical vapor deposition chamber.

30. (currently amended) The combination of claim 28 wherein said exit nozzle has said second pressure and said second temperature, such that said exit nozzle is an extension of said throat region consisting of the same dimensions as said throat region, said exit region ~~being configured to introduce~~introduces said atomized first and second chemical vapor deposition dopants and said carrier fluid in said chemical vapor deposition chamber.

31. (currently amended) The combination of a chemical vapor deposition chamber and an apparatus for delivering a plurality of chemical vapor deposition fluids to said chamber, comprising:

said chemical vapor deposition chamber for processing semiconductor substrates;

said apparatus ~~for~~ introducing TEOS and other dopant fluids at a high pressure, while not requiring the use of capillary tubes to create a pressure differential, said apparatus attached to, and in fluid communication with, said chamber, and having a cavity that prevents TEOS from reaching its auto-ignition point, said cavity comprising an inlet nozzle, a throat region and an exit nozzle,

said inlet nozzle ~~having a first diameter adapted to receive~~receiving a carrier fluid through a first diameter, and having a first pressure and a first temperature;

said throat region, having a first and second end, connected to said inlet nozzle at said first end, said throat region having a second diameter less than said first diameter and ~~adapted to receive~~receiving said carrier fluid from said inlet nozzle, said throat region having a second pressure lower than said first pressure and a second temperature, and having a first and a second aperture adjacent to said first and second ends ~~for~~ injecting, respectively, a first and a second chemical vapor deposition dopant into said throat region to allow for atomization of said first and second chemical vapor deposition dopants by said carrier fluid and mixing of said atomized first and second chemical vapor deposition dopants with said carrier fluid; and

said exit nozzle, connected to said throat region at said second end, having an exit pressure lower than said second pressure and a third temperature, said exit nozzle

having a third diameter greater than said second diameter to allow for a substantial decrease in pressure from said first pressure to said exit pressure, and ~~configured to introduce~~ introduces said mixed atomized first and second chemical vapor deposition dopants and said carrier fluid in the chemical vapor deposition chamber.

REMARKS

Applicants respond herein to the Office Action mailed March 8, 2007. Reconsideration is requested in view of the remarks below.

35 U.S.C. § 112 Issues

The Examiner has rejected claim 31 under 35 U.S.C. § 112, first paragraph, as failing to comply with the written description requirement. Specifically, the Examiner contends that claim 31 recites, "... while not requiring the use of capillary tubes to create a pressure differential ... ," and that this negative limitation is not found in the written description. Applicants respectfully disagree. The specification reads in pertinent part:

> The cross-flow injector operating under the conditions set forth in Table 1 above for helium would allow the introduction of TEOS and other dopant fluids at a relatively high pressure (29.2 psia), *and would not require the use of capillary tubes to create a pressure differential*. The choked, narrowed throat provides this needed pressure differential. Helium is used mainly to offset the auto-ignition concerns with TEOS.

Specification, p.13, l.30 - p.14, l.4 (emphasis added).

The Examiner further rejects claim 31 under 35 U.S.C. § 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which the applicants regard as the invention. Specifically, the Examiner states it is uncertain whether the recitation of "... while not requiring the use of capillary tubes to create a pressure differential ... " requires the apparatus itself to create a pressure differential, the apparatus not to require a capillary tube, or the apparatus to have capillary tubes as long as they do not create a pressure differential.

Applicants respectfully submit that the claim language is clear in its meaning: "... introducing TEOS and other dopant fluids at a high pressure, while not requiring the use of

capillary tubes to create a pressure differential ... ." This is supported by the specification as cited above, where "[t]he cross-flow injector ... would allow the introduction of TEOS and other dopant fluids at a relatively high pressure (29.2 psia), *and would not require the use of capillary tubes to create a pressure differential.*" As further stated in the specification, "The choked, narrowed throat provides this needed pressure differential." Applicants submit that the claimed negative limitation is clearly cited and supported by the specification. The apparatus does not require the use of capillary tubes to create a pressure differential because the narrow throat region provides this pressure differential.

35 U.S.C. § 103 Issues

The Examiner has rejected claims 1-5, 7-10, 12-17, 19-21, and 26-31 as being unpatentable over Gwyn (U.S. Patent No. 4,397,422) in view of Holt (U.S. Patent No. 5,501,397). Applicants respectfully traverse.

Applicants continue to submit that the Gwyn patent is merely directed to a non-analogous paint-spraying device for mixing and spraying different colorants utilizing a venturi mixer system. In the last office action response, applicants gave numerous examples from the specification showing direct application to chemical vapor deposition for the semiconductor arts, which the combination of Gwyn and Holt could not support; however, the Examiner was not persuaded. Applicants will respectfully withhold further comment on this issue until appeal, if necessary.

The Examiner further states that "chamber" meets the definition of "chemical vapor deposition chamber." Given to the numerous examples in the specification for the semiconductor arts, and the claims expressly requiring a "chemical vapor deposition chamber for processing a semiconductor substrate", applicants respectfully submit that the

combined prior art of Gwyn and Holt cannot possibly meet the definition for the claimed structure, "chemical vapor deposition chamber for processing a semiconductor substrate", whatsoever.

In the last office action response applicants further argued that the meaning of the term dopant intended by the inventors is within the common meaning of the term, i.e., for the deposition of reactants and other dopants within a chemical vapor deposition chamber. One of ordinary skill in the semiconductor arts would not interpret the term dopant to include dyes or paints for automobiles, as neither are reactants that alter the properties of a pure substance. The Examiner has stated "dopants are merely recited as intended use the first and second aperture of the throat region of the apparatus being claimed." March 8, 2007 Office Action, p.4. Applicants disagree. Applicants have claimed the introduction of certain fluids, such as TEOS, because the present invention must operate within the destructive environment established by the induction of these substances. The automobile sprayers of the cited prior art could not survive this environment, and the so-called "chamber" in the cited prior art cannot contain these substances.

With regard to the specifically described and claimed injection of TEOS, the Examiner held that the dopants were not positively cited. Since the application of TEOS is amply supported in the specification (see, e.g., Specification, p.2, ll.16-19; Specification, p.13, l.30 – p.14, l.4), applicants have amended the independent claims to define a TEOS resilient cavity or prevent TEOS from reaching its auto-ignition point. This must be true otherwise the cavity would chemically and structurally break down in an adverse TEOS environment, possibly in an explosive manner.

> Furthermore, the explosive nature of certain fluids, such as TEOS, requires the introduction of these fluids under safe temperature and pressure conditions.

Specification, p.3, ll.23-25.

> Another object of the present invention is to provide an apparatus and method which prevents TEOS or other liquids which are explosive in the presence of oxygen at high pressure and temperature from reaching their auto-ignition point.

Specification, p.4, ll.11-13.

Gwyn and Holt are completely silent regarding working with TEOS, or surviving the adverse TEOS environment that is normally associated with semiconductor processing. Applicants respectfully submit that having a cavity that can survive a semiconductor processing environ, i.e., a TEOS environment that does not allow the TEOS to exceed its auto-ignition point, makes the present invention patentably distinct over the cited prior art.

The Examiner further rejects claims 1, 13 and 28 stating the phrases "adapted to" and "configured to" merely require the ability to so perform. Applicants have amended these claims to more clearly define what is required by the invention, i.e., instead of "being adapted to receive", applicants have amended claims to state "receives" or "receiving". Instead of "configured to operate", applicants have amended the claim to state "operates". Applicants submit that since the specification adequately supported "adapted to receive" and "configured to operate", it necessarily supports "receives" and "operates". Similarly, applicants have amended the phrases following "for", such as "for injecting" to "injecting", in order to more clearly define the claimed invention.

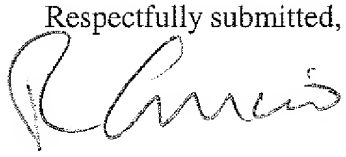
Furthermore, although the Examiner states that "chamber literally meets the definition of chemical vapor deposition chamber", this cannot be true of Holt. The chamber of the present invention MUST BE a chemical vapor deposition chamber for processing

semiconductor substrates. The phrase "for processing semiconductor substrates" is a structural limitation on the chamber. The Holt booth cannot meet this requirement. As applicants have stated previously, the paint spray booth of Holt would not work as a chemical vapor deposition chamber for receiving an atmosphere of mixed dopants that would allow for the simultaneous and uniform deposition of a material on a substrate. "The walls of the spray booth are formed from rectangularly shaped pads of removable plastic so that walls may be cleaned by simply removing the layers of film." Holt, col. 7, ll.22-24. Dopants and carrier gases used in the semiconductor arts (such as TEOS) would dissolve the plastic walls of the Holt booth. Holt's chamber is not, nor is it designed to be, TEOS resilient.

The Examiner further takes exception to the applicants' position that the apparatus and chamber of claim 1 are designed for chemical vapor deposition of dopants for the semiconductor arts. The restriction of claim 5 that the dopants comprise TEOS places a limitation on the structure of the apparatus and chamber, i.e., they must survive a hostile dopant environment. The Holt booth cannot accommodate this environment.

Applicants respectfully submit that the claims, as amended, bring the application into a condition for allowance.

Respectfully submitted,



Robert Curcio
Reg. No. 44,638

DeLIO & PETERSON, LLC
121 Whitney Avenue
New Haven, CT 06510-1241
(203) 787-0595